ESTABLISHMENT OF A POPULATION OF *DANAUS PLEXIPPUS* (LINNAEUS, 1758) (LEP.:DANAIDAE) IN SOUTHWEST EUROPE

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Summary

The migratory behaviour of *D. plexippus* has allowed it to expand over a very wide area. Although specimens have been arriving in Europe continually, there is no firm evidence that populations have become established, probably due to the absence or scarcity of suitable larval foodplants. Over the last few years, and coinciding with an invasion of *D. chrysippus,* a colony of *D. plexippus* has become established in Europe for the first time.

The biology and distribution of this population has been studied. The distribution seems to be determined by the presence of *Asclepias curassavica.* This plant, which also originates from the American continent, is naturalised in some coastal zones of the southern Iberian Peninsula.

The biological cycle of *D. plexippus* in the Iberian Peninsula is similar to that of the southern zone of its original distribution area. This, and the possible evolution of the colony, is discussed.

Introduction

The winter migrations of populations of *Danaus plexippus* from North America is a biological phenomenon of great interest, in that it constitutes an extreme case within the insects, and as such it has been proposed for protection in the *IUCN Invertebrate Red Data Book* (Wells *et al,* 1983).

The migratory capacity has led to an expansion of this species from the Pacific coast of North America to Hawaii (1841-1852), New Zealand (1940), Australia (1870) and India (1901). From the Atlantic coast the expansion has been less spectacular, with populations established on the Islands of Madeira (1860), Azores (1864), and the Canaries (1887) (Leestmans, 1975).

Specimens have been noted in Europe on many occasions. In Great Britain these are summarised by Leestmans, 1975 and Bretherton and Chalmers-Hunt, 1982. Records from the Iberian Peninsula include Leestmans, 1975; Fernandez, 1982 and Eiroa and Novoa, 1983. The species does not appear to have become established, probably due to the scarcity of its larval foodplant. In recent years, colonies of *D. plexippus* have been found in the area surrounding Málaga, in Spain. (Arrebola, 1982b, 1983; Tapia, 1982, 1983a and b; Martin, 1983; Verdugo, 1984 and Machado, 1985.)

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This colonisation followed an invasion by *D. chrysippus* which became temporarily established on the south and east coasts of the Iberian Peninsula, from Cádiz to Tarragona. (Gonzalez 1980; Martinez, 1980; Torres, 1980, 1981; Arrebola, 1982 a and b, 1983; Tapia, 1982, 1983 a and b; Lencina, 1983; Monserat and Montes, 1983, Ochotorena, 1983; Hanus, 1984, Martinez del Pino and Moreno, 1984; Maso and Perez, 1984 and Verdugo, 1984). Although the majority of *chrysippus* colonies have died out, *plexippus* is still present in its original colonisation sites.

Regular visits to the colonisation sites have been made throughout the year since 1983. Over this time, many specimens have been collected, mainly as larvae. All stages have been reared at room temperature, in the laboratory, using *Asclepias curassavica* as the larval foodplant. Examples of reared material have been deposited in the Museo Nacional de Ciencias Naturales (Madrid) and the Universidad Autónoma of Madrid.

Larval host-plants and distribution of major foodplant.

In the study zone, eggs and larvae of *plexippus* have always been found on *Asclepias curassavica* L., although others have found larvae on *Gomphocarpus fruticosus* L. (Machado, 1985.)

A. curassavica is likewise a native of the American continent (Tuttin, 1972; Guinea and Ceballos, 1984), being found mainly in tropical areas. Together with other species of this genus, and other members of the Asclepidiacea it makes up the spectrum of host plants of *D. plexippus*. Other host plants have been listed, by Ackery and Vane-Wright, (1984).

This plant is now naturalised at many sites on the coastal zones of the southern Iberian Peninsula. Although the history of its introduction and spread is not known with any certainty it is a common cultivated plant, usually in greenhouses, over much of Europe. It was introduced into Great Britain in 1692. (Chittenden, 1977). In principle, its naturalisation should not be difficult, as the species produces abundant, wind-transported seeds. In practice, it has a requirement for adequate water, a warm climate and a frost-free environment. The genus *Asclepias* includes species which form vegetative clones, requiring a complex cross-pollination mechanism. In practise, pollination requires a medium to large insect in order to transfer the large "pollinarium" between vegetative clones (Kephart, 1983; Morse and Fritz, 1983 and Morse, 1983).

At the present time, *A. curassavica* is naturalised in three main areas of the Iberian Peninsula: extensively around the villages of Torrox, Frigiliana, Nerja and Maro; a small colony around Churriana and finally in the province of Cádiz, mainly in the "de la Miel" river area of Algeciras. These sites cover a considerable area, and at Torrox we have found plants from the coast to more than 10 km inland. All sites

maintain the optimum ecological conditions — plants occurring in marginal zones along the courses of rivers that flow all the year and along the edges of irrigation channels. These observations agree with the published data on *A. curassavica* (Tuttin *et al,* 1972; Guinea and Ceballos, 1974).

We have found *D. plexippus* larvae and adults at all the major sites except within the Province of Cádiz. (See also Arrebola, 1982b, 1983; Tapia, 1982, 1983 a and b, 1984; Verdugo, 1984; Machado, 1985). Adult butterflies have been seen visiting the flowers of *A. curassavica* and *Nerium oleander*, as well as drinking from puddles or dew-covered plants.

Climatology of the area, and biology of *D. plexippus*

The whole coastal zone of Cádiz and Málaga is characterised by a mild climate, absence of winter frosts, and low annual rainfall (Table 1 and Figure 1). The area of Nerja is noted for its production of "tropical" crops such as custard apple, avocados, sugar cane, etc. *A. curassavica* is in leaf throughout the year, flowering from February until November.

Under these conditions, *D. plexippus* breeds continuously and eggs, larvae, pupae and adults can be found in every month. The density of larvae can reach considerable proportions, and it is not unusual to find plants defoliated, especially towards the end of November, with larvae wandering over the ground in search of fresh food. During the "winter" months of December and January, there is a noticable abundance of eggs.

Perhaps the most interesting fact is that this population and those present on islands such as Madeira, Canary Islands and the Azores, behave like non-migratory races, when, in all probability, they arose from migratory stock (Ackery and Vane-Wright, 1984).

Origin of the population

In principle, the origin of this population can be considered as American, since substantial objections exist to the theory of Macronesic origin (ie from Madeira, the Canaries and the Azores) for those specimens arriving in Europe (Leestmanns, 1975).

The date of arrival was probably 1981, a year when there was a huge immigration into Europe — for Great Britain, the records were summarised by Bretherton and Chalmers-Hunt (1982), and for the Iberian Peninsula by Fernandez (1982) and Eiroa and Novoa (1983). Although *D. plexippus* is recorded in northern Europe, especially Great Britain, every year, there is no evidence that the species has ever bred, outside the artificially maintained colonies in "Butterfly houses".

Verdugo (1984) has suggested that the species must have been present for many years, with the recent population increase corresponding to a period of drought in the Iberian Peninsula. We challenge this view,

MALAGA (altitude 34 m)						TARIFA (altitude 20 m)					
	Temperature °C (1931-1960)						Temperature °C (1945-1960)				
Month	Means			Absolute		Month	Means			Absolute	
	Day	Max.	Min.	Max.	Min.		Day	Max.	Min.	Max.	Min.
J	12.5	16.5	8.5	29.0	0.0	J	13.1	16.2	10.1	22.3	1.8
F	13.2	17.1	9.3	27.0	0.0	F	13.7	16.8	10.6	24.7	-2.1
M	15.0	18.8	11.1	27.8	3.0	M	15.0	18.1	12.0	23.4	3.1
A	16.7	20.5	12.8	31.8	5.2	A	16.2	19.5	13.0	25.6	6.2
M	19.3	23.3	15.2	34.0	7.6	M	18.3	21.7	14.9	28.3	8.0
J	22.8	26.6	19.0	39.0	12.0	J	20.9	24.4	17.5	30.8	15.2
J	25.2	29.2	21.3	40.6	12.0	J	23.0	26.5	19.6	35.3	14.4
A	25.6	29.8	21.6	40.4	12.0	A	23.5	27.0	20.0	37.0	15.0
S	23.5	27.5	19.6	39.6	11.0	S	22.3	25.6	19.0	30.8	13.8
O	19.7	23.4	15.9	34.6	4.2	O	19.8	23.0	16.7	29.1	9.0
N	15.8	19.7	11.9	29.4	4.0	N	16.9	19.8	14.0	27.8	6.8
D	13.3	17.1	9.4	29.2	2.0	D	14.3	17.2	11.4	23.6	3.2
Year	18.5	22.4	14.6	40.6	0.0	Year	18.1	21.3	14.9	37.0	-2.1

Table 1. Temperature variations in Málaga and Tarifa (after Font, 1983a).

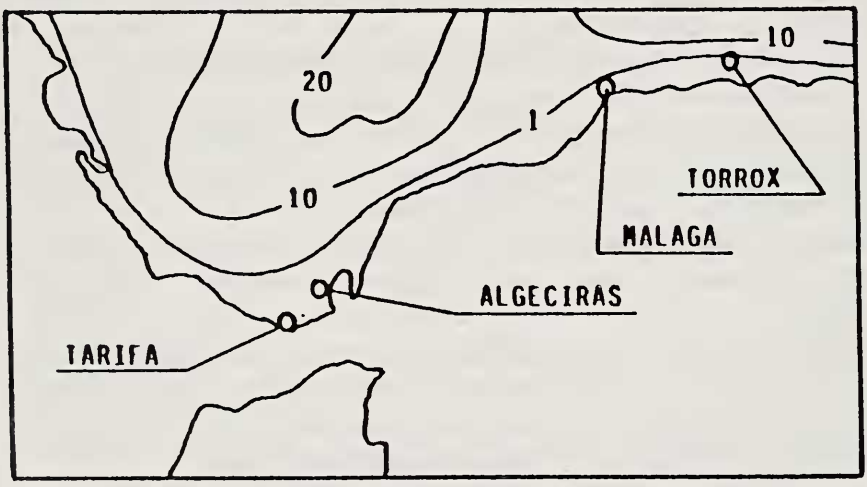

Figure 1. Number of days each year on the Iberian Peninsula when the minimum temperature is below 0°C (after Font, 1983b).

particularly in relation to the known biology of the butterfly and its foodplant. It is also inconceivable that such a conspicuous species would have been overlooked for such a time — the previous immigration being in 1973. Verdugo also cites information from local farmers to support his theory. Our evidence suggests that farmers are somewhat unreliable, many being unable to distinguish the various species of butterfly, and often confusing the larva of *plexippus* with that of *Papilio machaon,* which feeds locally on fennel.

Possibly evolution of the *D. plexippus* population

The status of the foodplant *A. curassavica* must be regarded as precarious. It occupies marginal zones in areas of high human

population and intensive agriculture, with the consequent problems of pollution from pesticides and urban waste. The plant also needs a permanently damp base, and the intermittent needs of agricultural irrigation do not always provide this condition. The autumn defoliation by larvae of *D. plexippus* may also stress the plants, although this is normal on the American continent (Morse, 1985).

The absence of *plexippus* in the area surrounding Algeciras is also interesting, as the foodplant is present and, geographically, colonising individuals should pass through this area. The impact of tourism on this area has been modest, and the agriculture remains traditional. Perhaps the significant tree cover makes the area unattractive for what is essentially an insect of open ground. In contrast, the impact of tourism on most of the *plexippus* areas has been high; agriculture is more intensive, and there is considerable irrigation and use of fertilizers. It is perhaps this last factor, combined with progressive deforestation, which gives the clue: according to Ackery and Vane-Wright (1984), *plexippus* is typical of open and nitrophilous zones, an accurate description of these areas.

There appears to be no effective competition for foodplant as, apart from the aphid *Aphis nerii* (which also feeds on *Nerium oleander*) no other invertebrates have been found regularly feeding on *A. curassavica*. The only other asclepiad supporting larvae is *Gomphocarpus fruticosus* (Machado, 1985), but this South African introduction is quite rare. No other host plants have been confirmed in Spain.

The presence of *plexippus* (as a pollinating insect) may well favour the spread of *A. curassavica*, within reasonable physical and climatic limitations, as although the effectiveness of *plexippus* as a pollinator has been questioned (Kwephart, 1983; Morse and Fritz, 1983, Morse, 1985), it is probably adequate for the needs of the plant. This in turn will tend to stabilise the colony of "European" *plexippus,* by a feedback mechanism.

We are faced with an interesting ecological "experiment", with the introduction of two alien species, one plant and one insect, both strongly interrelated, and relatively isolated from the rest of the flora and fauna.

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